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ABSTRACT

A factor analysis of test data measuring the results of the Appalachia Preschool Education Program is presented. The program involved three treatments for 3-, 4-, and 5-year-old children. A control group as well as the three treatment groups was tested. A total of 20 subtests was administered; the scores on these comprised the variables that were factor analyzed by principal components and varimax rotation techniques. The results of the factor analysis showed that the tests used in the evaluation of the program were measuring four principal factors; these were visual identification, psychomotor ability, vocabulary, and auditory recall. All of the factors except auditory recall incorporated five or more variables; auditory recall received a loading from only one variable. Analysis of variance showed that children who received all components of the Preschool Education Program and the children who received two components scored significantly higher than children in the other two groups. Also, the absence of significant differences between scores of children in the various groups on measures related to visual identification and auditory recall suggests that the Preschool Education Program fails to differentially affect the performance of children in those areas. (Author/CK)

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Factor Analysis of the Appalachia Preschool Education Program Test Data

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Factor Analysis of the Appalachia Preschool Education Program Test Data

Evaluation of the Appalachia Educational Laboratory's Preschool Education Program involved three treatments for 3-, 4-, and 5-year-old children. The three treatment groups were:

- A group which received only an instructional television program in their homes (TV only).
- A group which received the TV program plus weekly visits by a paraprofessional home visitor (TV-HV).
- A group which, in addition to the television program and home visitor, also made weekly visits to a mobile classroom (TV-HV-MC).

In addition, a control group similar in age and background was selected and tested for comparison purposes.

A battery of tests was administered to all youngsters. The tests used were the Marianne Frostig Developmental Test of Visual Perception, the Illinois Test of Psycholinguistic Ability (ITPA), the Peabody Picture Vocabulary Test (PPVT), and the Appalachia Preschool Test (APT). Altogether, 20 subtests were administered; the scores on those subtests comprised the variables that were factor-analyzed by principal components and varimax rotation techniques. The results of these analyses are the subject of this report.

There were two purposes involved in carrying out the factor analysis. First, since several different tests and their component subtests were used in the evaluation, it would have been useful to know which, if any, of those instruments were measuring the same things. Secondly, the analysis offered an efficient means of specifying overall program effects in relatively broad terms. In short, factor analysis appeared to be an efficient and meaningful way of dealing with a large body of data.

In order for a given subtest to be considered as loading on a factor, it must have had a factor loading of .40 or greater. The factor matrix after the varimax rotation revealed four main factors (Table 17.1). Factor names reflect the content of the various subtests which loaded heavily enough to be considered significant. Loadings at or above the criterion level are underlined for the reader's convenience and ease of identification. Descriptions of the subtests are found in Table 17.2.

Factor I is titled visual identification and incorporates ITPA Subtests 1 through 8 and the PPVT raw score. Complete descriptions of these tests are found in Technical Reports Nos. 13 and 15. Factor II could best be termed a measure of psychomotor ability. This factor consists of four subtests from the Frostig and the eighth subtest on the ITPA, which tests figure-ground discrimination. The Frostig subtests are described in Technical Report No. 16.

The third factor is vocabulary and program objectives; it is comprised of Frostig Subtest 5 and Subtests 1, 3, and 7 of the ITPA. Although the ITPA subtests load on Factor III to a lesser extent than on Factor I, they are still above the criterion level of .40. The subtests with heaviest loading on this factor are from the Appalachia Preschool Test (APT). This curriculum specific test has some vocabulary as its basic composition; it is described in Technical Report No. 14. ITPA Subtest 9 alone comprises the fourth factor, auditory recall. Two other ITPA subtests--Numbers 7 and 10--approached criterion for this factor.

It should be noted that the criterion level for accepting or rejecting a component's incorporation into a factor is arbitrary. Further, the choice of .40 as criterion would be considered conservative by some students of factor analysis.

Analysis of Factor Scores

Mean scores and analysis of variance summary tables for Factors I-IV are shown in Tables 17.3 through 17.10. The overall mean for each factor is set equal to zero, and corresponding group means are expressed in standard deviation units above (+) or below (-) zero. Relatively large positive values of treatment group means indicate that the group has relatively more of the quality described by that factor.

Analysis of variance on Factor I (visual identification) showed no differences between groups (Table 17.3). Group means for that factor, shown in Table 17.4, ranged from -.007 for TV only to .110 for TV-HV-MC.

Differences between group means on Factor II (psychomotor) were statistically significant ($P<.005$) as measured by the analysis of variance shown in Table 17.5. Group means are shown in Table 17.6. The TV-HV-MC and TV-HV groups displayed mean scores of .102 and .105 respectively, as compared to a score of .005 for the TV only group and -.027 for the controls.

Group means on Factor III (vocabulary) differed from one another at a statistically significant level (P<.001). The analysis of variance summary table appears in Table 17.7, and the group means for Factor III are listed in Table 17.8. Means ranged from a low of -.046 for the control group to a high of .345 for the TV-HV-MC group.

Group scores on Factor IV (auditory recall) did not differ from one another. The analysis of variance summary is shown in Table 17.9, and the group means are presented in Table 17.10. Again the control group scored the lowest (-.008), but the TV only group was highest (.204).

Summary

Briefly, the results of the factor analysis showed that the tests used in the evaluation of the Appalachia Preschool Education Program were measuring four principal factors. The factors were identified by reference to their constituent loadings as visual identification, psychomotor ability, vocabulary, and auditory recall. All of the factors except auditory recall incorporated five or more variables; auditory recall received a loading from only one variable.

Analysis of variance showed that children who received all components of the Preschool Education Program--the TV-HV-MC group--and children in the TV-HV group scored significantly higher than children in the other two groups (TV only and control) in measures which were related to the psychomotor and vocabulary factors. Since the vocabulary factor received loadings from four parts of the Appalachia Preschool Test, the finding of significance in this case indicates that the program was successfully achieving its objectives.

Similarly, the absence of significant differences between scores of children in the various groups on measures related to visual identification and auditory recall suggests that the Preschool Education Program fails to differentially affect the performance of children in those areas.

The results reported here failed to show that any of the testing which was carried out was superfluous. Although there was some overlap, in that various subtests loaded on more than one factor, there was no test which could have been eliminated without weakening or removing one of the factors.

The factors identified in this analysis are, in two cases at least, highly test-specific. For example, Factor I (visual identification) received loadings from eight of the ITPA subtests and from only one other source. The fact that a number of subtests from one instrument loaded on the same factor does not indicate that the subtests are not measuring different traits. However, in the context of the Preschool Education Program, the instrument appears to be measuring skills which are more similar than those measured by another test.

Implications for Future Programs

An implication derived from the analysis applies more to evaluation in general than to the Appalachia Preschool Education Program which is nearing completion of the development cycle. It is commonly recognized that test constructors should use factor analysis to reduce the needed number of items for a given test by examining the commonalities among the items. This factor analysis depicted in this report could somewhat justify reduction of the number of subtests needed in the testing battery itself. Most assuredly, a real problem involved in the evaluation of a preschool intervention program is the cost in both money and time required for testing. Following the implications from this present factor analysis by reducing the number of subtests could assist in somewhat relieving this problem in future programs.

Table 17.1

Factor Matrix
Varimax Rotation

Variable \ Factor	I Visual Identification	II Psychomotor	III Vocabulary	IV Auditory Recall
Frostig Subtest 1	0.25378	0.58088	0.10481	0.26315
Frostig Subtest 2	0.34788	0.65442	0.26338	0.31526
Frostig Subtest 3	0.21968	0.61649	0.36006	0.09685
Frostig Subtest 4	0.10131	0.31042	0.20508	0.07175
Frostig Subtest 5	0.29282	0.59610	0.44645	0.07846
PPVT Raw Score	0.61863	0.29103	0.34575	0.30126
ITPA Subtest 1	0.56999	0.25334	0.40314	0.19092
ITPA Subtest 2	0.61740	0.33555	0.21892	0.07685
ITPA Subtest 3	0.58301	0.30335	0.41442	0.31518
ITPA Subtest 4	0.64105	0.38724	0.17515	0.24187
ITPA Subtest 5	0.57038	0.17996	0.28528	0.15563
ITPA Subtest 6	0.55937	0.21409	0.23696	0.20450
ITPA Subtest 7	0.45326	0.22592	0.40079	0.35906
ITPA Subtest 8	0.40712	0.52776	0.26265	0.08505
ITPA Subtest 9	0.27212	0.19487	0.29376	0.49991
ITPA Subtest 10	0.39470	0.24730	0.23615	0.39247
APT Subtest 2	0.38452	0.35133	0.59041	0.23954
APT Interview	0.22976	0.18156	0.46451	0.12582
APT Subtest 5	0.24974	0.29449	0.61212	0.21179
APT Subtest 6	0.38455	0.35240	0.66071	0.23260

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Table 17.2

Descriptions of the 20 Variables (Subtests)
Used in Factor Analysis

Variable No.	Subtest Name	Description
1	Frostig Subtest 1	Hand-eye coordination in line drawing
2	Frostig Subtest 2	Figure ground discrimination
3	Frostig Subtest 3	Recognition of geometric shapes
4	Frostig Subtest 4	Discrimination of figural rotation
5	Frostig Subtest 5	Analysis and reproduction of simple patterns
6	PPVT (Raw Score)	Peabody Picture Vocabulary Test
7	ITPA Subtest 1	(Illinois Test of Psycholinguistic Ability) Vocabulary and hearing level
8	ITPA Subtest 2	Ability to match from a sample
9	ITPA Subtest 3	Vocabulary auditory association
10	ITPA Subtest 4	Association and stimuli goal
11	ITPA Subtest 5	Ability to describe objects verbally
12	ITPA Subtest 6	Vocabulary and ability to communicate gestures
13	ITPA Subtest 7	Ability to make grammatical transformations
14	ITPA Subtest 8	Figure ground discrimination
15	ITPA Subtest 9	Auditory recall
16	ITPA Subtest 10	Visual recall
17	APT Subtest 2	Test of cognitive objectives
18	APT Subtest 4	Interview (naming body parts)
19	APT Subtest 5	Cause-effect reasoning
20	APT Subtest 6	Measure of Cognitive Objectives

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Table 17.3

Analysis of Variance of Factor Scores for Factor I
(Visual Identification)

Source	d.f.	S.S.	M.S.	F	p
Between Groups	3	1.99	.66	.908	N.S.
Within Groups	391	2.85	.73		
Total	394	287			

Table 17.4

Group Means for Factor I (Visual Identification)

	TV-HV-MC	TV-HV	TV only	Control
Score $\bar{x}$	.110	-.005	-.007	.016
S.D.	.65	.90	.87	.93
N	95	128	66	106

Table 17.5

Analysis of Variance of Factor Scores for Factor II
(Psychomotor)

Source	d.f.	S.S.	M.S.	F	p
Between Groups	3	11.16	3.72	5.26	<.005
Within Groups	391	276.38	.706		
Total	394	287.54			

Table 17.6

Group Means for Factor II (Psychomotor)

	TV-HV-MC	TV-HV	TV only	Control
Score $\bar{x}$	.102	.105	.005	-.027
S.D.	.883	.926	.837	.678
N	95	128	66	106

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Table 17.7

Analysis of Variance of Factor Scores for Factor III
(Vocabulary)

Source	d.f.	S.S.	M.S.	F	p
Between Groups	3	48.16	16.05	27	<.001
Within Groups	391	232.38	.59		
Total	394	280.00			

Table 17.8

Group Means for Factor III (Vocabulary)

	TV-HV-MC	TV-HV	TV only	Control
Score $\bar{x}$	.345	.269	-.026	-.046
S.D.	.768	.861	.843	.584
N	95	128	66	106

Table 17.9

Analysis of Variance of Factor Scores for Factor IV
(Auditory Recall)

Source	d.f.	S.S.	M.S.	F	p
Between Groups	3	3.5	1.16	2.57	N.S.
Within Groups	391	177.00	.45		
Total	394	180.58			

Table 17.10

Group Means for Factor IV (Auditory Recall)

	TV-HV-MC	TV-HV	TV only	Control
Score $\bar{x}$	-.004	.006	.204	-.008
S.D.	.725	.656	722	.031
N	95	128	66	106

(8)

Table 17.11

Group Mean Factor Scores and Between Group Differences
Factor II (Psychomotor)*

		TV-HV-MC .102	TV only .005	Control -.027
TV-HV	.105	.003	.100	.132
TV-HV-MC	.102		.097	.129
TV only	.005			.032

Table 17.12

Group Mean Factor Scores and Between Group Differences
Factor III (Vocabulary)*

		TV-HV .269	Control -.046	TV only -.026
TV-HV-MC	.345	.076	<u>.391</u>	<u>.371</u>
TV-HV	.269		<u>.315</u>	<u>.295</u>
Control	-.046			-.020

*Mean differences which are underlined were significant ($P < .05$) on a Dunnetts' post analysis of variance test.

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